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ABSTRACT

The curriculum guide is designed to prepare students for employment in a specialized area of automotive services. Units are presented in a sequence which may be altered or shortened if trainee needs, time, or funds require. Methods and materials to enrich the course are suggested. General objectives for each unit are stated in terms of performance activities. Minimum proficiency should be what is necessary for entry employment in the area of automatic transmission services. The left-hand column of each unit contains a suggested topical outline; the right-hand column gives related factual information, as well as suggested teaching techniques and page references for selected textbooks. Topics for discussion and a sample final examination are provided. Old Ford or Chrysler transmissions are suggested because the skills learned from them can be transferred to current models. Instructors are advised that local dealers will often donate service instructional materials and discarded equipment. A glossary and bibliography are included. (MS)

ED 084399

Automotive Industries Occupations

AN INSTRUCTOR'S GUIDE FOR A PROGRAM IN

CE

AUTOMATIC TRANSMISSION SERVICES

TRADE AND TECHNICAL EDUCATION

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FOREWORD

Automatic Transmission Services was developed from the suggested services for automatic transmissions that are listed in the *Automotive Services Occupations*. The content may be used in secondary schools and adult programs to assist in preparing individuals who wish to enter the automotive field or to upgrade personnel already working as automotive mechanics.

Appreciation is expressed to Wallace Chapman, auto mechanics instructor at Hudson Valley Community College, Troy, for his efforts in developing the instructional materials. Additional information was contributed by Daniel Ashley, auto mechanics instructor at Hudson Valley Community College, Troy. Assistance relating to content was provided by Charles A. Stebbins, associate in the Bureau of Trade and Technical Education. The project was coordinated and the manuscript prepared for publication by Nelson S. Maurer, associate in the Bureau of Continuing Education Curriculum Development.

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MESSAGE TO THE INSTRUCTOR

Automatic Transmission Services is designed to prepare students for employment in a specialized area of automotive services. Units are presented in numerical order, but the sequence may be altered to accommodate the needs and backgrounds of the trainees. If time is limited, present the information as a unit and then have all the practice work that follows relate to a specific transmission. If funds are limited, obtain enough used transmissions of the same type so that each team of two students may have a practice unit with which to work. Older Ford or Chrysler transmissions are suggested because they have had few basic changes in the last several years, thus, skills learned from working on these units could be easily transferred to current models.

This guide suggests methods and materials that should enrich a course and help achieve a more effective presentation. The general objectives for each unit are stated in terms of performance activities that the student is able to do as a result of the instruction. The standards should be at least the minimum proficiency necessary for entry employment in the area of automatic transmission services. The left-hand column of each unit contains a suggested topical outline; the right-hand column gives related factual information, as well as suggested teaching techniques and page references for selected textbooks. At the conclusion of each unit, topics for review discussion are included. Also, a sample final examination is provided.

The use of instructional aids will greatly clarify the presentation of the material. A list of suggested aids is given in the bibliography. Excellent instructional materials are available from various automobile and automotive equipment manufacturers. Local dealers will often donate service instructional materials after they have presented the information to their own mechanics. Specific items may be located in the latest edition of *Automotive Instructional Material* published by the Automotive Service Industry Association. Many useful teaching aids may be fabricated easily from samples or discarded equipment.

New instructional aids are constantly being made available to instructors. Current releases of audiovisual aids are usually listed in issues of such publications as *American Vocational Journal*, *Industrial Education*, and *School Shop*. Also, new information relating to the automotive industry is available from automotive trade magazines and automotive enthusiasts publications.

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INTRODUCTION

OBJECTIVES

The student will be able:

- To assess the value of the course in meeting his perceived occupational needs
- To understand the importance and value of automatic transmission service to himself as well as to others
- To demonstrate a high regard for the safety of himself and his fellow workers during training and on the job
- To name and explain the operation of some of the popular automatic transmissions and indicate the contributions each made to the development of today's transmissions
- To explain the basic principles of hydraulics, torque, horsepower, and gear ratios as they apply to automatic transmissions
- To name and explain the basic functions of the major components of an automatic transmission

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Importance of Automatic Transmission Service	Indicate that over 90 percent of the cars sold in America today are equipped with automatic transmissions. These transmissions are composed of many parts and their operation is often more complex than any of the other major components of an automobile. Automatic transmissions are highly developed and usually have a long service life with a minimum amount of maintenance. But when service is required, it is expensive and must be done by a well-trained mechanic. Most dealerships employ one or more skilled automatic transmissions service technicians. Also, there is an opportunity for a mechanic to have his own business that specializes in automatic transmission repairs. Thus, there is a need and an opportunity for individuals who are able to service automatic transmissions.

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	The purposes of the course are: • To permit individuals who are now working as automotive mechanics to upgrade and update their knowledge in the rapidly changing area of automatic transmission service • To provide training in automatic transmission service for students in vocational and occupational education programs as well as other interested persons
II. Overview of Course	Indicate that the course will cover the operation and repair of the component parts of common automatic transmissions. Point out that each student will learn the theory from class presentations and the text and then will have the opportunity to apply this knowledge by working on live jobs. Indicate also such items as the length of each session, the number of sessions, the procedures to be followed in class, the reasons for homework, and in general, the expectations for each class member. Emphasize that there will be quizzes throughout the course as well as a final examination. Note that following the final examination, time will be allotted for a review of the test and answering questions about the course.
A. Individual needs	Determine the background and needs of each student. Use this information to adapt the course content to meet as many of the individual needs as possible, keeping in mind the available equipment. Develop a card data file for each student, listing address, telephone number, needs, goals, training, work experience, and other pertinent information. This file will be valuable in giving individual aid during the course. Also, it will help to maintain contact with students after employment. Many times former students can provide up-to-date trade information, training aids, and placement assistance.

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
B. Work habits and attitudes	Discuss the importance of good work habits and show how these might aid an individual in maintaining and improving his position. Include such items as: • Sense of responsibility to employer and other employees • Appreciation of safety rules and regulations • Accuracy and speed Discuss the attitudes that employers expect to find in employees. Indicate that many times the cause for a worker's dismissal is related to his poor work habits and not to his lack of knowledge. Emphasize the importance of developing good work habits and desirable attitudes during the course. (Ref. What Employers Want; Why Young People Fail To Get and Hold Jobs)
III. Course Requirements	
A. Prerequisites	It would be advantageous for students to be knowledgeable in the following areas: • Basic mathematics • Basic science • General understanding of automobiles • Shop safety
B. Textbook	If a textbook is to be used, give its title, price, and source. Arrange for a group order.†
C. Notebook	Indicate that a looseleaf notebook is necessary for keeping class notes, job information, specification booklets, and other materials distributed during the course.
IV. General Safety	Review general rules of safety for the service garage employee. (Ref. A, pp. 47-49; General Safety Instructions; Safety in Your Future; Your Guide to Safety as a Service Garage Employee)

†Reference citations are shown on page 48.

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Use films or transparencies that deal with safety to emphasize the importance of practicing safe work procedures when performing any type of repair work. Ask students to discuss their own experiences with accidents and have them indicate the safety procedures that should have been followed. Discuss the dangers of horseplay and hot rodding and give examples of the possible consequences of each. Show the location of fire extinguishers and discuss fire control procedures. Discuss the specific safety procedures for using the following: • Cleaning solutions • Steam for cleaning • Jacks and support stands • Compressed air
A. Protective clothing	State school policy relative to coveralls, shop coats, or uniforms. Mention possible storage areas for clothes and outer garments.
B. Safety glasses	Indicate the school policy relative to the wearing of approved safety glasses. Arrange for a group purchase of approved safety glasses for those who wish to have their own glasses.
V. Early Development of Automatic Transmissions	Show how the following affected the development of the automatic transmission: • Demand for simplified controls • Increased city traffic Mention some of the early attempts to simplify shifting including: • Model T Ford three peddle control • Owen magnetic electric shift

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• Reo automatic transmission
VI. Basic Mechanics	Explain in simple terms some of the basic laws and concepts that apply to automatic transmissions. Include the following points: • Hydraulics • Torque • Hea • Friction • Inertia • Momentum • Reactive force (centrifugal force) • Planetary gears Use visual aids, films, filmstrips, or demonstrations to assist in the presentation. *A very useful model of a planetary gear set can be obtained from the rear hub of a three-speed bicycle.*
VII. Basic Automatic Transmission Operation	Explain and illustrate by the use of films, pictures, and models the operation of an automatic transmission. Keep things in their simplest terms. Have students learn the names and functions of the following major components: • Converter • Gearset • Controls • Valve body • Governor Help students develop an awareness of the normal operating characteristics and shift points of an automatic transmission by having them note the operation of such transmissions on vehicles in which they ride or drive.

Review Discussion

1. Discuss the dangers related to the use of automobile jacks, transmission jacks, and compressed air hoses.

2. Explain the operation of the controls for a Model T Ford.

3. What are the major reasons for the increased popularity of automatic transmissions?

4. Explain why it took so many years to develop a successful automatic transmission.

5. Name the major components of an automatic transmission.

6. What is the function of an converter in an automatic transmission?

7. Why are planetary gears used in automatic transmissions?

8. List job situations in which a mechanic should wear safety glasses.

9. What is the price range of automatic transmissions on new cars? Do any cars come with an automatic transmission as standard equipment?

10. What is the average cost of an automatic transmission overhaul? What part of this cost is for parts?

11. Compare the investment required to establish an automatic transmission repair shop with that needed to establish a gas station.

12. What percentage of the new cars are equipped with automatic transmissions?

13. List the various manufacturers through the world that make automatic transmissions. Give the country of origin in each case.

14. Why do many manufacturers of automobiles purchase their automatic transmissions from an outside source?

15. Explain why an error in the reassembly of an automatic transmission can be expensive for the mechanic as well as the customer.

AUTOMATIC TRANSMISSION OPERATION

OBJECTIVES

The student will be able:

- To explain briefly the evolution of the automatic transmission
- To point out the need for a fluid coupling in an automatic transmission
- To explain the operation of the major units of three, four, and five element converters and give the advantages of each type of converter
- To explain how a stator multiples torque
- To point out the operation of a variable pitch stator
- To explain the operation of the planetary gearset under various operating conditions
- To explain the power flow in each of the popular American-made automatic transmissions
- To explain the operation of pumps, servos, bands, and clutches used in automatic transmissions
- To explain the operation of the valve body and governor under various operating conditions
- To point out the basic operation of some of the automatic transmissions used on foreign cars

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Evolution of the Automatic Transmission	Discuss the evolution of the automatic transmission touching upon the following: • Planetary gears (Model T) • Pushbutton shift (Owen magnetic) • Vacuum clutch (early Plymouth) • Automatic shifting (Reo)

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• Automatic overdrive (Borg-Warner) • Four speed with coupling (Hydramatic) • Converter only (Dynaflow) • Three speed with converter (common) • Future developments
II. Basic Operation	Review the basic operation of automatic transmissions. *Take sufficient time with this topic and be sure that the students are knowledgeable about the operation of an automatic transmission in order that they may profit from future lessons.* Discuss each major automatic transmission component separately. If possible, assign a transmission to every student so that he may have the opportunity of working with each major component as it is being discussed in class. *Do not allow students to disassemble the entire transmission at this time as it may confuse the students and might lead to the instructor having to reassemble many of the practice transmissions.*
A. Fluid coupling	Demonstrate the operation of a fluid coupling by the use of two electric fans. (Ref. B, p. 140; Ref. D, pp. 396-398; Ref. G, p. 573)† Explain the functions and operation of the component parts of a fluid coupling including: • Slippage (ability to idle) • Driving member • Guide ring (prevents turbulence) • Reactive force (centrifugal force) • Present use on cars Use films, pictures, and the actual parts to assist in the presentation of the topic.

†Reference citations are shown on page 48.

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Explain why fluid couplings do not multiply torque.
B. Torque converter	Explain the functions and operation of the component parts of a three element torque converter including: • Oil flow (rotary and vortex) • Pump (driving member) • Turbine (driven member) • Stator (Ref. E, pp. 224-225; 229; Ref. G, p. 584 fig. 43-4, 43-5)
	Use films, pictures, and the actual device to assist in the presentation of the topic.
	Explain why some torque converters cannot be serviced so must be replaced. (Ref. E, pp. 225-231)
	Discuss the advantages and disadvantages of various types of torque converters including: • Operation (smooth) • Torque developed (higher in complex units) • Service life (long) • Construction costs (high) • Gas mileage (poor)
1. Stator	Use films, pictures, and the actual device to show how the stator multiples torque. Include such items as: • Free wheeling of stator (coupling point) • Free wheeling units (roller and sprag) • Variable pitch stator • Defective units and effects

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	(Ref. B, pp. 148-149; Ref. G, p. 585) Explain why the variable pitch stator was dropped from production even though it worked well.
2. Pumps	Explain the function and show examples of the following types of oil pumps: • Gear • Vane • Rotor • Gear rotor (Ref. C, p. 363) Explain how a rear pump allows a vehicle to be started by being pushed.
3. Planetary gearset	Explain why planetary gears are well adapted for use in automatic transmissions. Identify the individual parts and explain the power flow through a simple and compound planetary gearset. (Ref. A, p. 416; Ref. C, pp. 351-353) *Review the concept of power flow several times throughout the remainder of the course.* Have students develop a chart showing the various conditions that are possible with planetary gears. Have students trace the power flow through the practice transmission for each speed. Indicate that direct drive always has two units locked together.
4. Bands	Explain the construction and operation of automatic transmission bands. Include the following items: • Single wrap • Double wrap • Lining material • Servo piston

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• Accumulator • Method of adjustment (manual and automatic) (Ref. C, p. 358) Explain why bands have been replaced by clutches in many automatic transmissions.
5. Clutches	Show examples of multiple disk clutches and explain the operation of the following: • Lined disk • Wavy disk • Plane disk • Concaved disk • Clutch servo piston • Accumulator • Release spring Explain how the accumulator cushions the application of a clutch or band. Explain the advantages of a disk clutch. Indicate that the lack of oil pressure and excessive heat often damage multiple disk clutches. (Ref. C, pp. 355-357)
6. One-way clutches	Explain the operations and functions of the following overrunning or one-way clutches: • Roller • Sprag Explain how a one-way clutch is used to lock planetary gear units. Point out that a one-way clutch provides an extremely smooth shift and its operation requires no servo or other controls. (Ref. C, pp. 358-359; Ref. E, pp. 226-227)
7. Governor	Show examples and explain the operation and function of governors used in automatic transmissions.

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Point out that the governor's operation is directly related to the speed of the car. (Ref. E, pp. 237-240)
8. Valve body	Use a chart and the actual unit to show the operation and functions of the various valves within a valve body including: • Manual • Shift • Pressure regulator • Governor • Throttle • Kickdown • Vacuum modulator • Other (Ref. D, pp. 403-412)
	Emphasize that the valve body is the control unit of the automatic transmission.
	Explain how the shift valves are in a balanced condition between the governor and the throttle-valve pressure and that their movement is related directly to car speed and throttle position or manifold vacuum. (Ref. E, pp. 236-242)
9. Cooler (heat exchangers)	Show examples and explain the importance and function of automatic transmission coolers including the following: • Standard equipment on most V-8 engines (installed in bottom of radiator) • Optional accessory for trailer package (installed in front of radiator)
III. Foreign Transmissions	Point out that there are several variations of the popular three-speed transmission with torque converter used on foreign cars. Indicate that although the number of most of these foreign transmissions in this country is small, a mechanic should know something about them in case servicing is required.

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Explain briefly the design and operation of the following automatic transmissions used on foreign vehicles: • Three-speed Borg-Warner (basic) • Four-speed Borg-Warner • Four-speed Mercedes-Benz (with fluid coupling) • DAF (belt driven) • Hobbs (without fluid coupling or torque converted) • Renault (electric controls) • Volkswagen stick shift (semiautomatic) • Volkswagen full automatic

Review Discussion

1. Explain why the development of a successful automatic transmission took so long.
2. Why do transmissions with fluid couplings often have four speeds, while converter-equipped transmissions have three speeds?
3. Why have full-converter-nonshifting automatic transmissions (Dynaflow) been phased out in favor of the converter plus three-speed-gear automatic transmissions (Turbo Hydramatic)?
4. Explain why the pump is the heart of an automatic transmission.
5. Give several reasons why planetary gears are preferred for use in automatic transmissions.
6. Why do many automatic transmissions employ compound planetary gearsets rather than simple planetaries?
7. What gear results when two units of a planetary are locked together?
8. What is the major advantage of a multiple disk clutch over a band for locking a planetary gearset in an automatic transmission?
9. What is the purpose of a governor in an automatic transmission? Have automatic transmissions been built without governors?
10. How automatic is an automatic transmission? What speeds does the transmission select for itself?

AUTOMATIC TRANSMISSION SERVICE

OBJECTIVES

The student will be able:

- To perform minor service such as checking and adding fluid and making band and linkage adjustments
- To remove and reinstall an automatic transmission
- To diagnose automatic transmission problems by:
    - Inspecting automatic transmission fluid for color and odor
    - Performing a road test
    - Examining sediment and other materials in pan
    - Using pressure and vacuum gauges
    - Inspecting defective internal components
    - Using trouble shooting and oil flow charts
- To clean an automatic transmission case
- To disassemble and clean the components of an automatic transmission
- To inspect the cleaned components of an automatic transmission and discriminate between serviceable and defective parts
- To service individual assemblies of an automatic transmission
- To reassemble and adjust an automatic transmission

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Minor Service	Point out the advantages of explaining to the customer how regular inspection and service to an automatic transmission will prevent early failures.
A. Fluid	Discuss the types of fluid used in automatic transmissions.

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Explain how to do the following services related to the fluid in automatic transmissions: • Checking (only when engine is hot and running) • Changing (follow manufacturers' recommendations) • Draining (transmission and converter) (Ref. F, pp. 26-5—26-6)† *Caution students that the fluid in an automatic transmission might be over 250° F. so care must be exercised during the draining process to prevent serious burns.* Have students practice checking, changing, and adding fluid to automatic transmissions.
B. Linkage	Demonstrate how to make the following linkage adjustments to automatic transmissions using special tools and gauges: • Throttle • Manual shift Explain how linkage adjustments affect the performance of the vehicle. (Ref. F, pp. 26-10—26-11)
C. Bands	Demonstrate why and how to make the following band adjustments to automatic transmissions using special tools and gauges: • Front band • Rear band • Self-adjusting bands (Borg-Warner) (Ref. F, pp. 26-14—26-15) Have students practice making linkage and band adjustments to automatic transmissions.

†Reference citations are shown on page 48.

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
II. Major Service	
A. Diagnosing transmission (unit in vehicle)	Explain the advantages of diagnosing transmission problems while the unit is still in the vehicle. Point out that some transmission problems may be corrected without removing the unit from the vehicle which saves time for the mechanic and money for the customer. Demonstrate the procedures for diagnosing and correcting minor transmission problems while the unit is still in the vehicle. Include the following items: • Level, color, and odor of fluid • Band and linkage adjustments • Internal oil pressures of transmission (using gauges) (Ref. F, pp. 26-13—26-14) • Amount and kind of sediment and foreign material in sump or pan • Action of clutch and bands (using compressed air) (Ref. F, pp. 26-16—26-17) • Stall test of transmission (if recommended for that specific unit) (Ref. F, pp. 26-12—26-13) Indicate that if the transmission is still malfunctioning, it will have to be removed from the vehicle for further servicing. Explain how the information gained from diagnosing an automatic transmission that is still in the vehicle may be used later during the repair process. Have students practice diagnosing automatic transmissions that are still in vehicles. Explain why it is important to follow a definite procedure when diagnosing automatic transmissions. See appendixes A and B.
B. Removing transmission	Demonstrate the procedures for the removal of transmissions from vehicles. Include the following items: • Safety

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• Use of automatic transmission jacks • Placement of car and engine supports • Use of penetrating oil to free frozen bolts • Draining of the transmission fluid • Use of plugs to prevent dripping of oil and entry of dirt • Care during the removal of the transmission • Care during the removal of the converter • Covering of the converter to prevent entry of dirt • Use of pins and gauges to insure correct alinement for reassembly (Ref. B, pp. 339-342) Have students practice removing automatic transmissions from vehicles.
C. Cleaning exterior of transmission	Explain why it is important to clean thoroughly the exterior of an automatic transmission. Demonstrate how to clean the exterior of automatic transmissions including the necessary safety precautions.
D. Disassembling major units of transmission	*If a large class is working on a number of identical transmissions at the same time, prepare handout sheets that give the procedures for disassembly, cleaning, service, and reassembly, including torque specifications, of the major units of the practice transmission. These sheets may be developed from information found in the service manual. At key points throughout the procedure sheets, insert questions that emphasize the types of information mechanics use as they repair automatic transmissions. To help during the reassembly process, use exploded views which may be found in catalogs issued by manufacturers of replacement parts.*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Explain and demonstrate the procedures for the disassembly of the major units of automatic transmissions. Include the following: • Checking transmission end play (Ref. B, p. 342) • Removing the: • Converter (cover opening) • Pump (use special pullers) (Ref. B, p. 343) • Valve body • Main drive assembly • Making guide marks (to speed reassembly) Have students practice cleaning the exterior and disassembling the major units of automatic transmissions.
E. Cleaning major units of transmission	Explain why the cleaning of an automatic transmission requires more than a soaking in a hot tank for a half an hour. Point out why careful cleaning is vital to a successful overhaul. Indicate that a tiny particle of foreign material left in a critical part (valve body or governor) can cause a transmission to fail. Discuss and demonstrate the following cleaning equipment: • Steam cleaner and pressure washers • Dip tanks Explain and demonstrate how to clean the major units of automatic transmissions. Include the following cleaning precautions: • Parts not to be cleaned — bands, clutches, seals, and nonmetallic parts • Parts requiring special care — valve bodies, pumps, planetaries, and screens

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Caution students to use eye protection when they clean and air dry parts. Explain how a careful examination of the individual parts during the cleaning process may provide information that would assist in the repair of the transmission. Point out the usefulness of checking the following: • Major units for failures • Screens and fillers for foreign material • Clutches and bands for defective linings • Pumps for excessive clearance and scoring • Seals in servo units and clutch pistons for damage Have students practice cleaning major units of automatic transmissions. *Check students work carefully and point out properly cleaned units as well as any errors that exist.*
F. Servicing individual assemblies of transmission	Explain how quality work helps reduce customer comebacks with all its duplicated effort, cost, and ill will. *As students service the individual assemblies, visit all groups regularly to check their progress. At the same time, question each student enough to be sure that he understands the repair procedures he is doing and that he is able to identify the component parts of each assembly.*
1. Pumps	Demonstrate the procedures for disassembling, cleaning, inspecting, and reassembling pumps used in automatic transmissions. Include the following: • Checking clearances with feeler gauge • Inspecting parts for scores or damage (Ref. B, pp. 196-197)

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Indicate that a pump with excessive clearance or scores must be replaced. Have students practice servicing pumps. Caution students not to reverse the gears during reassembly because it may cause an excessive noise or complete failure of the pump. If necessary, mark parts for correct reassembly.
2. Planetary unit	Demonstrate the procedures for cleaning and inspecting planetary units used in automatic transmissions. Include the following: • Marking assembly • Inspecting needle bearings • Timing planetary gears (Ref. B, p. 199) Have students practice servicing planetary units. Indicate that planetary gears usually last the life of the vehicle, but, if they do fail, normally all parts are damaged and the whole assembly must be replaced.
3. Bands and servos	Demonstrate the procedures for disassembling, inspecting, and reassembling bands and servos used in automatic transmissions. Include the following: • Noting which end of band contacts case • Inspecting band lining and replacing if grooves are worn away • Checking band and linkage for cracks • Checking servo unit for scores or cracks • Replacing servo seals (Ref. B, p. 344) Have students practice servicing bands and servos.
4. Clutches	Demonstrate the procedures for disassembling, inspecting, and reassembling multiple disk clutches used in automatic transmissions.

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Include the following: • Using correct tools (clutch return spring compressor) • Noting direction of dish of disks • Noting position of notches • Inspecting lined disks and discarding ones that are worn • Inspecting plain disks and discarding those that are discolored, scored, or warped • Inspecting clutch piston bores for scores and replacing seals • Inspecting clutch hubs for scoring and damaged splines and replacing if necessary • Soaking lined disks in type A fluid before reassemblying • Using extreme care not to damage seals during reassembly Have students practice servicing clutches.
5. Valve body	Demonstrate the procedures for disassembling, inspecting, and reassembling valve bodies used in automatic transmissions: Include the following: • Using an exploded view as a guide • Having a clean work area (use newspapers) • Laying parts out carefully (like the exploded view) • Disassembling one section at a time • Checking actual unit against exploded view • Noting carefully the location of all springs

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• Checking each valve and being sure it moves freely • Discarding any valve body that is heavily scored, warped, or does not allow the valves to move freely • Tightening valve body bolts according to manufacturer's specifications (Ref. B, pp. 344-347) Explain why any service to a valve body must be done very carefully. Prepare illustrations that show the various circuits in an automatic transmission and have students indicate the oil flow in each circuit with different colors. Have students practice servicing valve bodies. Emphasize the importance of keeping track of all parts because individual replacement parts for a valve body are not available. Thus, lost parts mean the purchase of a new unit.
G. Reassembling transmission	Demonstrate the procedures for reassembling automatic transmissions. Include the following: • Checking position of thrust washers • Tightening valve body to case • Checking main shaft end play • Using guide pins for pump assembly, if necessary • Assembling all linkages • Adjusting bands to factory specifications (Ref. B, pp. 356-358) Have students practice reassembling transmissions. Emphasize that an automatic transmission must be reassembled correctly to work. Almost right is not good enough!

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
H. Testing transmission	Demonstrate the procedures for testing automatic transmissions with a dynamometer, speed handle, or impact wrench. Show how to make the following checks: • Pressure • Servo operation • Clutch operation Point out that it is possible also to check the operation of the servo unit and clutch piston by using compressed air. Have students practice testing automatic transmissions.
I. Reinstalling and adjusting transmission	Demonstrate the procedures for the reinstallation and final adjustment of automatic transmissions. Include the following: • Alining converter • Alining transmission • Adjusting linkages • Adding fluid Have the students practice reinstalling and adjusting automatic transmissions.

Review Discussion

1. Explain what parts are damaged in an automatic transmission when the fluid becomes too low.
2. Describe the special care necessary in the removal and replacement of an automatic transmission.
3. Explain how some makes of automatic transmissions have eliminated band and throttle linkage adjustments.
4. Explain why cleanliness is important when overhauling a transmission.
5. Explain methods that mechanics use to help them remember the location of all the parts of an automatic transmission on its initial disassembly.
6. Explain why it is important to spend time trying to find out why an automatic transmission is malfunctioning before removing the unit from the vehicle.

7. Explain how to locate and make positive diagnosis of automatic transmission fluid losses including converter seal or gasket, front pump gasket or bolts, and vacuum modulators.

8. Explain how to check an automatic transmission for a leak in the high-clutch piston apply circuit using an oil pressure gauge.

9. Give your diagnosis of an automatic transmission which slips in direct drive and in which the fluid smells burned, looks black, and contains small dark particles.

10. Give your diagnosis for each of the following situations occurring in a nonoperating automatic transmission when the pan sediment shows:

    - Black mud with some small nonmetallic flakes
    - A large amount of very fine aluminum powder
    - Many small, irregular shaped steel items and parts of springs and chips
    - Fine cast iron powder and filings
    - Bronze powder with some small bronze slivers

11. Give your diagnosis for each of the following noises in an operating automatic transmission:

    - A whine in all speeds except direct drive
    - A buzz like sound which is more noticeable when the transmission is hot
    - A very high-pitch whine, almost a whistle, noticeable only when the vehicle is in motion

12. What is the problem when a Ford with a Cruiseomatic transmission seems all right except that the shifts are harsh and occur at too high a speed?

13. What is the problem with an older American Motors car with a Borg-Warner automatic transmission that shifts without slippage and even though the car has good acceleration it will not go over 50 m.p.h.?

14. Explain the effects of low vacuum due to poor engine condition or the loss of vacuum due to leaking lines or diaphragm on the performance of a vacuum modulator controlled transmission such as the Ford Cruiseomatic.

15. Discuss the approximate cost of a repair error which requires the removal and replacement of the automatic transmission. Who pays for this error?

SAMPLE FINAL EXAMINATION

Sample Final Examination Part I — Fill-In Statements

Directions: For each statement, write the word or phrase that, when inserted in the blank, will complete the statement correctly.

1. Torque signals are transmitted to an automatic transmission by the VACUUM MODULATOR and THROTTLE VALVE LINKAGE.

2. In an automatic transmission, the exact moment of shifting is controlled by the interaction between the pressure signals from the throttle valve and the GOVERNOR.

3. In a torque converter, the torque multiplication at the coupling point is ZERO.

4. The part of the torque converter that is mounted on an overrunning clutch and serves as a torque multiplier is the STATOR.

5. During the reassembling of an aluminum Powerglide transmission, one of the first items to be reinstalled in the case would be the REVERSE CLUTCH PISTON.

6. Two methods of cooling automatic transmissions are by the use of a (an) HEAT EXCHANGER and FINS ON THE CONVERTER COVER.

7. The major advantage of a variable pitch stator in a torque converter is its ability to IMPROVE TORQUE MULTIPLICATION.

8. Three devices that may be used to hold a planetary reaction member to the transmission case are BANDS, CLUTCHES, and FREEWHEELING UNITS.

9. The front pump of an automatic transmission is driven by the CONVERTER.

10. Two types of oil pumps used in automatic transmissions are GEAR and ROTOR.

11. The stator freewheels when the torque converter reaches the COUPLING POINT.

12. The manual shift selector position that normally produces the highest oil pressure in an automatic transmission is REVERSE.

13. The rear pump of an automatic transmission is driven by the OUTPUT SHAFT.

14. The main advantage of using a vacuum modulator to control an automatic transmission is that it REQUIRES LITTLE ADJUSTMENT.

15. The force that moves the shift valve is supplied by the GOVERNOR.

16. All three units of a torque converter turn at approximately the same speed at the COUPLING POINT.

17. Most three element torque converters multiply torque about TWO or THREE times.

18. The purpose of the accumulator in a clutch or band apply circuit is to CUSHION the shift.

19. Too high an engine idle will cause an automatic transmission to shift HARSHLY.

20. On a vehicle with an automatic transmission equipped with a vacuum modulator, poor engine condition that results in low manifold vacuum will raise the SHIFT POINTS.

21. If an automatic transmission shifts normally when hot but does not shift or the shifts are delayed when cold, the most common cause would be DIRT IN THE GOVERNOR OR VALVE BODY.

22. A converter contaminated with metallic particles resulting from a severe transmission failure can often be saved and reused by the use of a (an) FLUSHING MACHINE.

23. A very smooth shift is accomplished when parts of a planetary unit are held by a (an) SPRAG OR ROLLER CLUTCH.

24. The most popular method of locking together two units of a planetary gear set is by a (an) MULTIPLE DISC CLUTCH.

25. Three ways of moving spool valves are by the use of OIL PRESSURE, SPRING PRESSURE, and MANUAL LINKAGE.

Sample Final Examination Part II — Multiple Choice

Directions: For each statement, place the letter of the choice that completes the statement most accurately in the space to the left of the statement.

D 1. The oil used in the torque converter

(A) is very thick
(B) must not get thin when heated
(C) causes an overdrive effect
(D) can be type A or type F

C 2. The turbine is part of the

(A) planetary gear box
(B) stator
(C) converter
(D) pump

C 3. The purpose of the vacuum modulator and modulator valve in a Turbo Hydramatic transmission is to

(A) permit smooth clutch and band engagements
(B) establish the range of transmission operation selected by the driver
(C) change main line oil pressure in the transmission to meet engine needs
(D) prevent a kickdown unless the transmission is in high gear

B 4. The primary function of the clutches and bands in a Torqueflite automatic transmission is to

(A) make the transmission shift smooth
(B) transmit engine torque through the planetary gearset to the drive shaft
(C) hold the vehicle when park is engaged
(D) release engine torque while the engine is idling

A 5. The purpose of the "Select Shift" feature of Ford's Cruiseomatic transmission is to

(A) permit the driver to shift gears manually
(B) provide an extra forward speed range
(C) give the driver an option of a kickdown from third to second
(D) prevent excessive engine speed in first and second

C 6. The main purpose of the vacuum-modulator is to correlate transmission main-line oil pressu[illegible] with

(A) car speed
(B) throttle position
(C) engine vacuum
(D) engine speed

D 7. The number of elements in a Turboglide torque converter is

(A) one
(B) two
(C) three
(D) five

B 8. An example of a *fully* automatic *two* speed transmission is the

(A) C-4 Ford
(B) cast-iron Powerglide
(C) Torqueflite
(D) Turbo Hydramatic

C 9. The aluminum Powerglide transmission uses a planetary gear system for

(A) neutral and drive
(B) neutral and reverse
(C) reverse and low
(D) reverse, low, and drive

A 10. A torque converter drives the

(A) input shaft
(B) stator
(C) impeller
(D) one-way clutch

C 11. Types of automatic transmission front pumps commonly used in current models include

(A) gear and rotor
(B) gear, rotor, and slipper
(C) gear, rotor, and vane
(D) gear, rotor, vane, and slipper

B 12. To adapt an aluminum Powerglide transmission for use with an engine that has more horsepower the mechanic would change the

(A) snap rings
(B) clutch disks
(C) servo pistons
(D) brake drums

D 13. In an aluminum Powerglide transmission, the gear attached to the cover of a multiple disk clutch is the

(A) pinion gear
(B) short pinion gear
(C) ring gear
(D) sun gear

D 14. To determine if a lined disk in a multiple disk clutch can be used again, the mechanic would use

(A) a micrometer
(B) a dial-indicator
(C) a straight edge
(D) visual inspection

C 15. The planetary gear set used in a Powerglide transmission is composed of

(A) one sun gear, a set of long pinions and short pinions
(B) one sun gear, a set of long and short pinions, and a ring gear
(C) two sun gears, a set of long and short pinions, one ring gear, and a carrier
(D) one sun gear, a set of long and short pinions, and a carrier

C 16. Two operating mechanisms used with most planetary gearsets are the

(A) valve body and pump
(B) torque converter and sun gear
(C) band and multiple disk clutch
(D) torque converter and ring gear

A 17. An automatic transmission brake band is operated by the

(A) servo
(B) manual valve
(C) clutch piston
(D) stator

C 18. In a planetary gearset, the ring gear is held stationary to provide

(A) low
(B) reverse
(C) low and reverse
(D) low and high

C 19. In a planetary gearset, both parts of the planetary are locked together to provide

(A) neutral
(B) low
(C) high
(D) reverse

A 20. All forward speeds of a three-speed Fordomatic transmission require the application of the

(A) front clutch
(B) front band
(C) rear clutch
(D) rear band

B 21. In a Fordomatic transmission the speedometer drive gear is driven by

(A) a pin
(B) a ball
(C) friction
(D) oil pressure

C 22. To remove the reverse piston from the case of an aluminum Powerglide transmission, the mechanic would use

(A) a spring compressor
(B) a puller
(C) compressed air
(D) a big hammer

B 23. The first thing to do when diagnosing automatic transmission problems is to check the

(A) oil pressure and shift points
(B) transmission fluid level
(C) linkage and band adjustment
(D) pan for sediment

C 24. If the steel check ball in the clutch drum is loose enough to fall out, the mechanic should

(A) install a new ball
(B) stake the ball in place
(C) obtain a new clutch drum
(D) rebuild the clutch drum

C 25. After an aluminum Powerglide transmission is removed from a car, the converter may be taken out by

(A) removing four bolts
(B) removing a snap ring
(C) slipping the converter off the input shaft
(D) prying the converter loose from the case

D 26. If a Powerglide equipped car creeps in neutral, it means that the

(A) oil pressure is too high
(B) brake band is not applying at the proper time
(C) idle speed is too high
(D) low band is not releasing at the proper time

C 27. A harsh upshift in a Ford equipped with a C-4 automatic transmission is normally caused by

(A) an improper throttle valve linkage adjustment
(B) the front clutch not applying at the proper time
(C) a defective vacuum modulator
(D) an improper band adjustment

D 28. The sun gear in a planetary gear system meshes with the

(A) ring gear
(B) clutch gear
(C) pinion cage
(D) planet pinions

A 29. If the sun gear is turned while it is locked with the planet pinion cage, the ring gear will turn

(A) at the same speed as the sun gear
(B) slower than the sun gear
(C) faster than the sun gear
(D) at the same speed as the rear wheels

B 30. The function of the large spring in the rear multiple disk clutch of a Fordomatic transmission is to

(A) apply the clutch
(B) release the clutch
(C) take up the shock of engagement
(D) make the shift into high

C 31. The valve that is operated by the linkage connected to the actual shift lever is called the

(A) shift valve
(B) shift control valve
(C) manual valve
(D) main control valve

D 32. An upshift is produced in an automatic transmission when the governor pressure overcomes the throttle-valve pressure that is acting on the

(A) pressure regulator valve
(B) detent shift valve
(C) high-low valve
(D) low to drive shift valve

B 33. The main purpose of an accumulator is to apply a clutch or band more

(A) firmly
(B) gently
(C) rapidly
(D) slowly

D 34. When a Torqueflite automatic transmission is in direct drive, both multiple disk clutches are engaged and

(A) the front band is applied
(B) the rear band is applied
(C) both bands are applied
(D) both bands are released

D 35. An automatic transmission in which the fluid smells burned will normally require

(A) the fluid to be changed
(B) new seals
(C) a new clutch pack
(D) a complete overhaul

Sample Final Examination Part III — Problems

1. *Directions:* In the space provided, indicate with an "A" those parts from the display that could be used in the reassembly of a transmission and with a "U" those parts that should be discarded.

(U) 1. Sprag race (GAULED)

(A) 2. Clutch disk, lined (OPERATIONAL)

(U) 3. Planetary gear (TOOTH BROKEN)

(A) 4. Servo piston (OPERATIONAL)

(U) 5. Stator support (GROOVE WORN BY THRUST WASHER)

(U) 6. Clutch disk, steel (DISCOLORED)

(U) 7. Front pump housing (SCORED)

(A) 8. Governor (OPERATIONAL)

(U) 9. Clutch return spring (OVERHEATED)

(U) 10. Servo piston (TORN SEAL)

(U) 11. Governor (STUCK VALVE)

(U) 12. Pump screen (PLUGGED)

2. *Directions:* From the list given below, number in the correct order in the space provided the steps a mechanic would perform when he disassembles the front clutch of a Cruiseomatic automatic transmission. Cross out any unnecessary steps.

(No) Press off hub

(7) Remove pressure plate

(10) Remove clutch return spring

(2) Remove input shaft

(8) Use clutch return spring compressor

(No) Remove lip seal

(1) Remove input shaft retaining ring

(5) Remove clutch disks

(9) Remove clutch return spring snap ring

(No) Remove freewheeling unit

(12) Remove clutch inner and outer seals

(3) Remove fiber thrust washer

(11) Remove clutch applied piston

(No) Drive out retaining pin

(4) Remove clutch hub

(6) Keep disks in order

3. Problem: The engine of a Plymouth equipped with a cast-iron Torqueflite automatic transmission races when the shift is made into high.

Directions: From the list given below, number in the correct order in the space provided the diagnostic steps a mechanic would perform to determine the probable cause of the above problem without removing the transmission from the vehicle. Cross out any unnecessary steps.

(No) Check universal joints

(4) Check internal oil pressures of transmission

(No) Check front pump on transmission

(6) Remove transmission pan and examine contents

(5) Road-test vehicle

(No) Check governor

(1) Check transmission fluid for level, color, and odor

(No) Check engine vacuum

(2) Check motor mounts

(No) Adjust bands

(3) Adjust throttle valve linkage

(No) Remove transmission from car and examine high clutch

Sample Final Examination Part IV — Matching

Directions: In the space provided to the left of each item in Column I, write the letter of the word or phrase from Column II which best matches the item in Column I.

Column I		Column II
K	1. Accumulator	A. Determines shift points
E	2. Compensator valve	B. Member of planetary gearset
I	3. Coupling point	C. Overrunning clutch
A	4. Governor	D. Pressure regulator
F	5. Pawl	E. Increases main line pressure during acceleration
N	6. Servo	F. Locks drive shaft
C	7. Sprag	G. Shift valve
B	8. Sun gear	H. Driven member
H	9. Turbine	I. Drive shaft speed equals engine speed
M	10. Vortex flow	J. Multiple disk clutch
		K. Cushions band or clutch application
		L. Manual valve
		M. Motion of fluid through pump, turbine, and stator
		N. Applies a band or clutch

USING AUDIOVISUAL MATERIALS

Audiovisual materials are both a tool for teaching and an avenue for learning and are well suited to stimulate a high level of class involvement. It is suggested that audiovisual materials be used with a variety of learning activities and that the instructor not devote an entire class session to the use of such materials. The following suggestions may help the instructor use audiovisual materials more effectively in class presentations.

Plan the Presentation (Organization and Methods)

Always preview any audiovisual material to become familiar with its content and see that it correlates with the lesson. Adult students dislike *time fillers* and inappropriate presentations. While previewing, prepare comments which might answer such questions as the following:

- What is being illustrated?
- Why is the presented material important?
- What are the important terms and understandings being presented?
- What are some appropriate topics which could be used to stimulate class discussions?

Prepare the Equipment and Materials

Request the required equipment several days ahead of time from the director of adult education or person in charge of audiovisual equipment. Then, see that it is delivered prior to the starting of the class. Check the equipment to see that it is all in working order. Before the class begins, practice using the equipment to become acquainted with its operation. Arrange the room so that everyone can see and is comfortable. Have a screen ready and place it so that the least amount of outside light is reflected onto it. The wall may be used, but a screen is much more desirable. The larger the room and the larger the audience, the larger the screen that is needed. Be sure there is a table for the projector, an electrical outlet, an extension cord, and a spare projector lamp in case the one in use fails.

If the class is held during the day, be sure the room can be darkened and ventilated. Check to see that the lights can be turned off without shutting off the power to the projector. At the conclusion of the presentation, allow the fan on the machine to cool the equipment for a few minutes before completely shutting off the power.

Orient the Class (Background Material)

Explain the subject matter that is going to be presented. Discuss the important terms used and indicate the main points that will be covered.

Make the Presentation

Have the film threaded and the projector ready for use. Stop the film or filmstrip for discussion as the need arises during the showing instead of waiting until the presentation has been completed. A filmstrip may be used as a whole or as a part, whichever is appropriate to the needs of the trainees. It may also be stopped at any frame for discussion or questions. At the end of the showing, make your comments and encourage discussion and questions from the trainees.

Summarize the Concepts and Understandings

Itemize the important learnings on the chalkboard as they are contributed by the class. Allow time for the trainees to raise other questions which may lead to a more complete understanding of the topic. Encourage trainees to keep some kind of notation for future review.

Evaluate the Knowledges Acquired

Prepare a list of questions which might assist trainees to evaluate how well they have learned the important points of the presentation. One approach might be for the instructor to present the question and pause for a few moments to allow the trainees to form their answers before responding. Interest could be generated by asking the trainees to keep track of the number of their correct answers.

Followup With Opportunities To Explore New Knowledges

Introduce several new topics for discussion which will motivate the trainees to a further investigation of the subject.

Return the Equipment and Materials

After the class is over, make arrangements to return the equipment and school-owned audiovisual materials. For an item ordered from an out-of-school source, complete the required attendance report, prepare the material for mailing, and make arrangements for its prompt return.

PREPARING AND USING TRANSPARENCIES

The overhead projector gives the instructor an opportunity to improve the classroom learning situation. It is easy to operate, but its effectiveness depends upon the ability to select and prepare appropriate visuals. Items for making transparencies are readily found in books, magazines, and other printed materials. Also, transparencies may be made easily by the instructor. The following suggestions are given for those who might wish to make their own original transparencies.

- Select only content that is appropriate for a transparency. The material presented should complement the verbal commentary; if words alone can do the job, then a visual is not necessary.
- Keep the content of the transparency simple. Present only one main idea or concept at a time.
- Design the transparency for horizontal projection.
- Organize the content of the transparency carefully. Use a limited amount of words and keep the number of lines under seven.
- Use color only for emphasis and identification of parts.
- Use letters that are at least one-quarter of an inch high. Use a lettering guide or dry-transfer letters to produce attractive headings and labels. Drawings and symbols should be at least one quarter the total heighth of the image area.
- Leave a three-quarter of an inch margin on all sides of the transparency.
- Use a folding, hinged, or sliding mask to control the rate of disclosure when more than one step is included on a transparency.
- Use overlays to develop concepts, show steps, and note contrasts. Keep master and overlays in register with crosshair marks in opposite corners. Mount all overlays with emulsion side down. To provide for a flexible showing order, hinge overlays from different sides of the mount.
- Use a pointer to identify a specific part, but remove it quickly or lay on transparency, because a hand-held pointer cannot be kept steady and thus becomes distracting.

GLOSSARY

Accelerator: A foot-operated pedal which controls the throttle valve in the carburetor.

Accumulator: A hydraulic device used to cushion the engagement of a band or clutch.

Annulus: The internal ring gear in a planetary gear system that operates in conjunction with the sun gear, pinion gears, and pinion carrier.

Automatic transmission: A transmission that automatically provides varying gear ratios to suit operating conditons.

Axle ratio: The ratio of the r.p.m. of the propeller shaft to the r.p.m. of the rear wheels; a gear reduction in the differential.

Backlash: The amount of play in a mechanical system; in the case of gears, the amount one gear can move back and forth without moving the gear into which it is meshed.

Balanced valve: A type of hydraulic valve that produces pressure changes proportional to movement of a mechanical linkage or variations in spring pressure.

Ball bearing (antifriction): A bearing made of a series of hardened steel balls contained in hardened steel inner and outer races.

Ball check valve: A valve consisting of a ball and seat which permits fluids to pass in one direction only.

Bearing: A curved surface around a shaft which supports it and permits it to rotate with minimum wear and friction.

Bore: The diameter of a hole or cylinder.

Burr: A feather edge of metal left on a part that has been cut with a file or other cutting tool.

Bushing: A bearing or removable sleeve that has a bearing contact area on its inner surface.

Casehardened: A piece of steel that has its outer surface hardened while the inner portion remains relatively soft.

Clearance: The space between two parts and considered to be filled with lubricating oil when the mechanism is running.

Check valve: A valve which allows a liquid to pass in one direction only.

Clutch: A device that connects and disconnects members which are rotating at different speeds.

Clutch disk: A device in the clutch assembly that is faced with friction material and which transmits power.

Clutch shaft: The shaft coming from the transmission on which the clutch is assembled.

Coefficient of friction: The ratio of the force needed to overcome the friction of two objects in contact with each other.

Compensator valve: A valve in automatic transmission that increases the pressure on the bands and clutches during heavy acceleration.

Cone clutch: A cone-shaped device that is forced into a cone-shaped depression in another part in order to lock the two parts together. By means of this action, power is transmitted.

Coupling point: The point at which the pump and turbine in a torque converter are traveling at the same speed; the drive is almost direct at this time.

Detent: A small depression in a shaft or rod into which a pawl or ball drops to hold a sliding member in position.

Dial indicator: A gauge with a needle moving across a dial face which indicates very small variations in size or movement.

Diaphragm spring: A type of spring used in some clutches that is shaped like a disk with tapering fingers pointed inward or like a wavy disk (crown type).

Direct drive: A condition in which the engine crankshaft and drive shaft turn at same r.p.m.

Eccentric (off center): A protrusion on a shaft that rubs against or is connected to another part in order to change rotary motion to reciprocating motion.

Efficiency: The ratio between the output of a machine to its input.

Energy: The capacity or ability to do work.

Feeler gauge: An accurately made metal strip or blade used to measure the clearance between two parts.

Feeler stock: Strips of metal of precise thickness used to measure clearences between two parts.

Fluid coupling (fluid drive): A device in the power train used to transmit power from the engine to the transmission input shaft. Also called fluid drive.

Freewheeling mechanism: An overrunning clutch in the transmission that transmits motion in one direction only.

Friction: The force which opposes motion.

Friction bearing: A bearing that uses sliding action to reduce friction between parts.

Friction disk: A flat disk in a clutch assembly that is faced on both sides with friction material and used to transmit power.

Full throttle: The wide-open position of the throttle created when the accelerator pedal is pressed all the way down to the floor board.

Gasket: Material usually made of cork that is placed between two surfaces to provide a tight seal between them.

Gasket cement: An adhesive material applied to gaskets.

Gear ratio: The number of turns made by the driving gear compared to one turn made by the driven gear.

Gears: Mechanical devices used to transmit power or turning effort from one shaft to another.

Gear-type pump: A pump that develops force by the turning of a pair of matching gears.

Governor: A device that controls the speed or position of another device.

Heat exchanger: A device used to transfer heat from one object to another.

Helical gear: A gear that has teeth cut at an angle so that at least two pairs of teeth are in contact with each other at all times.

Hone: An abrasive stone used to remove a small amount of material.

Horsepower: A measurement of an engine's ability to perform work.

Hunting gearset: A gearset in which the number of teeth are not proportional so it takes several revolutions for each drive-pinion tooth to contact every tooth in the driven gear.

Hydraulic pressure: The force exerted through the medium of a liquid.

Hydraulics: The science of liquids in motion.

Hydraulic valve: A valve operated by hydraulic pressure.

Idle speed: The speed of the engine without load.

Impeller: The pump or driving member in a torque converter.

Inertia: The property of an object to resist any charge in speed or direction.

Internal gear: A gear with the teeth pointing inward toward the center of the gear.

Kickdown: An arrangement in some automatic transmissions which produces a downshift when the accelerator pedal is pushed to the floor.

Linkage: A series of rods, yokes, or levers connected together to transmit motion from one unit to another.

Locknut: A nut turned down against a holding nut in order to prevent loosening.

Multiple-disk clutch: A clutch with more than one friction disk.

Needle bearing: A bearing composed of many small diameter rollers fitted into a race.

Oil seal: A device that prevents the escape of oil.

Orifice: A small opening or hole.

"O" ring: A ring made of a special rubber-like material that is fitted into a groove to provide a sealing action.

Output shaft: A shaft that transmits power from within a device to another object.

Overdrive: A unit in the power train that permits the propeller shaft to drive faster than the engine crankshaft.

Overrunning clutch: A type of clutch that transmits motion in one direction only.

Pascal's law: Pressure exerted anywhere on a confined liquid is transmitted undiminished in every direction.

Pawl: A device that can be moved into a detent, slot, or groove to hold a part stationary.

Piston: A movable part in a cylinder that receives or transmits motion as a result of pressure changes in the cylinder.

Planetary gear system: A unit consisting of a central sun gear surrounded by two or more planet pinion gears which mesh with a ring or internal gear.

Planet carrier: The part of a planetary gearset that contains the shafts upon which the planet pinion gears turn.

Planet pinion gears: The gears in a planetary gearset that mesh with the sun gear as well as with the ring or internal gear.

Power train: The parts that transmit the power developed by the engine to the live axle.

Preloading: The application of a small amount of pressure to an anti-friction bearing to assure alinement of parts and a minimum amount of play in the system.

Pressure plate: The part that locks against the friction disk when the clutch is engaged.

Pressure regulator: A device that prevents excessive pressure from developing in a system.

Pressure-relief valve: A valve in an oil line that relieves excessive pressures that might be developed by an oil pump.

p.s.i.: Pounds per square inch.

Puller: A tool that permits the removal of one part from another without damage.

Pump: A device that admits a fluid into itself through an entrance port and forces the fluid out through an exhaust port. Also, the driving member in a torque converter.

Quadrant: A portion of a circle mounted on the steering post which contains the transmission control lever.

Relief valve: A valve that opens at a preset pressure.

Ring gear: A large gear in the differential that transmits power from the propeller shaft to the live axle. Also, the outer gear in a planetary gearset.

Rotor pump: A type of pump that uses a pair of rotors to produce oil pressure and oil circulation.

r.p.m.: Revolutions per minute.

Runout: The amount a wheel or gear lacks of being true with its axle or shaft.

Seize: One surface adhering to another due to corrision or lack of lubrication.

Servo: A device in a hydraulic system that converts hydraulic pressure into mechanical movement.

Shift valve: A valve in the transmission produces the shifts from one gear ratio to another.

Shim: A thin piece of material installed between two objects to increase the distance between them.

Shrink fit: A tight fit in which the outer piece is heated in order that it will fit over the inner piece. When the parts cool to room temperature they fit tightly.

Slip joint: A joint in the power train which transfers torque and at the same time allows a shaft to change its effective length.

Snap ring: A "C" ring that is snapped into a groove in a shaft or bore and used to hold bearings, thrust washers, and gears in place.

Solenoid: A device which uses electromagnetic force to produce mechanical movement.

Spline: A slot or groove cut in a shaft or bore.

Spool balance valve: A hydraulic valve in an automatic transmission that balances incoming oil pressure against spring control pressure to produce a steady pressure which controls some other unit.

Spool valve: A hydraulic control valve shaped somewhat like a spool.

Sprag clutch: A clutch that allows rotation in one direction but prevents any movement in the other direction.

Spring: A device that yields under pressure and returns to its original position after the pressure is removed.

Spur gear: A gear with teeth cut parallel to the longitudinal centerline.

Stall speed: The maximum r.p.m. that can be obtained by the engine of a vehicle equipped with a torque converter when the transmission is placed in drive, the engine operated at full throttle, and the vehicle held stationary by the brakes.

Stator: A part of the torque converter that changes the direction of the fluid and makes torque multiplication possible. Also called a reactor.

Stud: A headless bolt that is threaded on both ends.

Sun gear: The center gear in a planetary gear system that meshes with a series of planet pinion gears.

Thrust washer: A bronze or hardened steel washer placed between two moving parts to provide a bearing surface and prevent longitudinal movement.

Torque: Turning or twisting force.

Torque converter: A device in the power train that transmits power from the engine through a fluid to the remainder of the drive train. It is able also to multiply engine torque.

Torque multiplication: The ability of an automatic transmission to increase engine torque by using a torque converter.

Torque wrench: A special wrench that indicates the amount of torque being applied to a nut or bolt.

Torus: An oil filled member of a torque converter.

Transmission: The device in the power train that provides different ratios between the engine and the rear wheels.

Troubleshooting: The investigation necessary to determine the cause of a problem. Also implies the correction by eliminating the cause.

Turbine: A wheel with a series of blades placed at an angle to a shaft so that a moving fluid is able to impart rotary motion to the shaft.

Turbulence: A disturbed, irregular motion of a fluid.

TV rod: The rod that extends from the foot throttle linkage to the throttle valve in the automatic transmission.

Vacuum: An enclosed area in which the pressure is lower than atmospheric pressure.

Vacuum modulator: A device in an automatic transmission that changes the main line hydraulic pressure to meet changing engine loads.

Valve: A device used to open or seal an opening.

Vane: A plate or blade attached to a shaft and moved by a fluid.

Vent: An opening from an enclosed area through which a fluid may pass.

Vibration: A rapid back and forth movement.

Viscosity: The internal friction of a fluid.

Viscous: The resistance of a fluid to flow.

Vortex flow (torque converter): The whirling motion of the oil as it moves from the pump through the turbine and stator and back into the pump again.

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APPENDIX

APPENDIX A

Diagnosing an Automatic Transmission

Directions: Use the following procedure to help identify the possible problems in an inoperative automatic transmission. Steps may be bypassed when the results of one check need to be verified by another test lower on the list.

1. Warm up vehicle and check transmission fluid level.
2. Road-test the vehicle to check customer's complaint and engine performance.
3. Check engine idle speed.
4. Check for defective engine mounts.
5. Perform stall test (if applicable) and compare results with manufacturer's specifications.
6. Check vacuum modulator for leaks or breaks in line.
7. Adjust throttle linkage and bands (where applicable).
8. Check pressure in transmission.
9. Remove pan and examine contents.
10. Remove and overhaul valve body and governor.
11. Check operation of band servos and multiple disk clutches with compressed air.

Note: If the malfunction cannot be corrected with the above procedure, remove the transmission from the vehicle, and use the "Applied Unit Table" to further localize the problem to a specific clutch or band.

APPENDIX B

Applied Unit Table

Directions: Use the following information to help localize the cause of malfunctions in an automatic transmission to a specific clutch or band. Usually, this may be further verified by the use of a pressure gauge or compressed air. Consult service or factory manuals for other models not listed.

MODEL	QUADRANT POSITION	UNITS APPLIED
Ford C-4	D (low)	Forward clutch and one-way clutch
	D (second)	Forward clutch and intermediate band
	D (high)	Forward clutch and reverse and high clutch
	1 (low)	Forward clutch and low and reverse band
	R (reverse)	Reverse and high clutch and low and reverse band
Ford C-6	D (low)	Forward clutch and one-way clutch
	D (second)	Forward clutch and intermediate band
	D (high)	Forward clutch and reverse and high clutch
	1 (low)	Forward clutch and low and reverse clutch
	R (reverse)	Reverse high clutch and low and reverse clutch
Turbo-Hydramatic 300 (Powerglide)	D (low)	Low band
	D (high)	Forward clutch
	L (low)	Low band
	R (reverse)	Reverse clutch

MODEL	QUADRANT POSITION	UNITS APPLIED
Turbo-Hydramatic 350	D (low)	Intermediate overrun roller clutch and forward clutch
	D (second)	Intermediate overrun roller clutch, intermediate clutch, and forward clutch
	D (high)	Intermediate clutch, direct clutch, and forward clutch
	1 (low)	Intermediate overrun roller clutch, forward clutch, and low and reverse roller clutch
	R (reverse)	Direct clutch and low and reverse clutch
Turbo-Hydramatic 400	D (low)	Forward clutch and roller clutch
	D (second)	Forward clutch, intermediate sprag, and intermediate clutch
	D (high)	Forward clutch, direct clutch, and intermediate clutch
	1 (low)	Forward clutch, roller clutch, and rear band
	R (reverse)	Direct clutch and rear band
Torqueflite	D (low)	Rear clutch and overrunning clutch
	D (second)	Rear clutch and front band
	D (high)	Rear clutch and front clutch
	1 (low)	Rear clutch and rear band
	R (reverse)	Front clutch and rear band